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A CONTRIBUTION TO THE SURGERY OF THE BRAIN, WITH THE REPORT OF TWO CASES OF TUMORS OF THE CEREBELLUM WHICH WERE LOCATED AND ON WHICH OPERATIONS WERE PERFORMED.

By William H. Hudson, M.D.,
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Case I.—*Cyst of cerebellum located in the right lobe, in which two operations were performed, with ultimate recovery.*

History. Julia R., aged nine and one-half years. Family history good. Father healthy, strong, and well nourished. Mother very healthy and strong. The patient was one of twins, the other dying at birth. Both had supernumerary little fingers. The brothers and sisters are all in perfect health, the youngest children being twins, also with supernumerary little fingers. Father by a previous marriage had several children, two of the daughters dying of rapid pulmonary tuberculosis during the winter of 1894–95. The other children by the former marriage are healthy and apparently not tuberculous. The two daughters who died of phthisis lived in the same house with the family.

The patient, up to the summer of 1895, was very healthy and active. She was well developed and strong, and the brightest of the children. During the summer she began to complain of headache, which she said was in her eyes and forehead; it was occasionally so severe as to cause her to cry. Toward December these attacks became very frequent, and compelled her to remain in the house most of the time. The location of the pain was changed, and was now in the back of the head, and down the back of the neck, on the right side. During this period she vomited occasionally, always just as she got out of bed in the morning. She did not complain of nausea, but had frequent attacks of vertigo, which she called "swimming in the head." These attacks were usually in the morning when she was getting up. Her parents do not remember having noticed any clumsiness or staggering during this time; but from being the errand girl of the household, she became inactive and disposed to lie in bed. When not suffering, her parents thought her mind was as active and bright as it had ever been.

During the month of January, 1896, Dr. B. F. Rae, Jr., of Lafayette, was called to see her. He found it necessary to give her morphine to control the pain in the head. He noticed that her gait was staggering and that her eyesight was defective. He did not examine the optic disks. Dr. Rea saw her frequently during the winter and early spring months, and suggested the probability of a brain tumor. In May I saw the case with him, with a view to an operation if I could satisfactorily locate the tumor.

When I first saw the patient she was a well-nourished, healthy-looking girl. Her head was large, measuring twenty-two inches in circumference. Her eyes were very prominent and protruding, and, at every effort to move them, oscillated from side to side. She could not count fingers accurately, but could see your hand and could point out the doors and windows. The movements of the eyes were restricted in all directions. The abducens of the right eye was more defective than the other ocular muscles. She could close her eyes only when an effort was made, and could keep them closed only for an instant. Her mother said she had not closed her eyes when she slept for some months; that several weeks ago her eyes were so badly crossed that she could only see the " whites of the eyes," and since that time her eyes had been " rolling in the head all the time." The pupils were widely dilated and did not react to the light.

There was paresis of the right facial nerve, noticeable when she showed her teeth and when she smiled. There was no disturbance of sensation on any part of the face or neck. The tongue was protruded in a straightforward manner, and moved freely from side to side. Swallowing was not interfered with. Hearing was good and the same in both ears. Taste and smell were normal. The pulse was 65 beats to the minute and the respiration 18 to the minute. She never lost her appetite except during the time of intense headache, and at times it was voracious.

The patient was suffering with headache of moderate severity, located in the back of the head, and neck on the right side. The muscles of the neck were stiffened, and the head was slightly retracted. Her mother informed me that frequently when she awoke in the morning her head was drawn far back, and that it would take several hours, with "hot applications and rubbing" before she could " straighten her neck." She complained of severe pain in the neck when I attempted to lift her head.

There was no pain on percussion with a rubber hammer, but pain was elicited by firm pressure over the right occipital region, especially over the right cerebellar fossa. The grasp of the left hand was much weaker than the right, and the left leg was much weaker than the right. Both knee-jerks were totally absent.

As the patient lay in bed she could move her arms and legs freely, and, with the exception of the weakness in the left side, there was no marked deficiency in them. Co-ordination was good except to the fine tests. When she attempted to sit up her power of maintaining an equilibrium was markedly disordered. She could sit in a chair by using great care, but usually she held to the sides or the arms with her hands or leaned hard against the back. She did not appear comfortable sitting up, and evidently preferred lying in bed, where she stayed most of the time. When asked to walk she attempted to do so, but with some reluctance, usually falling as she got up from the chair, or as she got out of the bed. When assisted to her feet and steadied she would walk forward six or eight feet and then gradually turn to the left, going, as she turned, three or four feet farther; here she would fall unless caught. Her gait was staggering and uncertain, but she would usually go the above specified distance before falling. When she turned around she would walk back in the same manner, turning toward the left and falling as before. One cannot say that the falling was constantly in a certain direction. When asked to stand, which, by your aid, she could do, and occasionally without aid if slow and careful in her movements, a vibratory action would pervade the muscles of her whole body, especially marked in the muscles of her trunk; then after an instant she would sway to and fro, and then lose equilibrium entirely and fall. She did not have the characteristic "saddle-back," but there was a slight forward turn to the pelvis, and the trunk stood above the pelvis in a very tottering, uncertain fashion, suggesting at once that the muscles of the back were much weaker than the muscles of the legs. I further tested the muscles of the trunk by placing her flat on the abdomen on a table; she could raise her head and shoulders only a short distance above the table; turned on her back, this defect was equally marked. As a control experiment, I compared her in these movements with her healthy sister of near her own age, and the difference was very perceptible.

There was intense optic neuritis in both eyes. The disks were concealed by a very prominent swelling with a central depression. The veins were enlarged and partly obscured in the swollen disks. The arteries were not seen until the edge of the swelling was reached. There were hemorrhagic points in the right eye. The loss of sight had occurred in both eyes at about the same time.

Recently the headache had grown less severe, and the vomiting had entirely ceased. The patient complained less frequently of vertigo. Her parents thought her mind was not as good as it had been. She kept her bed most of the time.

During the following twenty days I saw her frequently. The headache diminished until she ceased to complain of it, or rather she became so apathetic as to cease to recognize the pain. She became more stupid; at times her mind wandered. She lost strength in her legs, and there was a marked loss in her ability to walk. Instead of turning to the left on attempting to walk she would turn shortly to the right, making irregularly the segment of a small circle. This turning to the right was as constant as the turning to the left had been when I first saw her. Toward the last her legs became so weak that she could not stand. She lost control of the sphincters, her mind was rapidly failing; in short, all of her mental faculties were rapidly becoming "blotted out." Her mother was very emphatic as to her head having grown very rapidly recently, and called my attention to this fact of her own accord. I examined her head by percussion according to Macewen, and found the percussion note altered from that of health, the resonance being greatly increased, indicating that there was much ventricular distention.

The headache, vertigo, vomiting, and staggering; the paresis of the muscles of the trunk; the optic neuritis coming on early in both eyes and producing blindness; the hemorrhagic points in the retina; the failure of mind, the prominent eyes, the nystagmus, and the increased resonance on percussion over the ventricles suggested a tumor in the cerebellum. The late appearance of staggering as a symptom in the disease and the paresis of the right facial and right abducens nerves, the tenderness to firm pressure over the right cerebellar fossa, and the weakness of the left arm and leg indicated with reasonable certainty that the tumor was located in the right cerebellar lobe, implicating the middle lobe by extension or by pressure. The freedom of the other cranial nerves indicated that the tumor was not at the front of the cerebellum, and probably accessible.

Of the nature of the lesion I could form no satisfactory opinion, although the great frequency of tuberculous growths in this part of the brain, and her exposure to tuberculous surroundings in the beginning of her sickness, led me to believe it probably tuberculous. She did not, however, present any signs of tuberculosis, but was remarkably well nourished. A glioma or a gliosarcoma was quite as probable.

Operation. On June 15th I operated under ether narcosis.[1] Before the operation Dr. Hilt was requested to be prepared to make artificial respiration should the breathing fail during the operation. The incision was made from a point midway between the left mastoid process and the external occipital protuberance just over the superior curved line, extending from this point about one-half an inch above the superior curved line of the right side to a point near the tip of the right mastoid process. The incision was not made with one sweep of the knife, but in sections of about two inches each, all hemorrhage from each section being under control before the next section was made. Instead of cutting the muscles from their insertions, the periosteum was scraped back with a blunt-pointed elevator and all the muscular attachments separated with the same instrument. By this method, and the use of aseptic wax for a few bleeding vessels in the bone, the hemorrhage was reduced to a minimum. The opening through the occipital bone was made with a small oval-pointed, semicircular edged chisel, and enlarged with rongeur forceps to one and one-half inches long by one and one-quarter inches wide. This was very easily done, for the bone was not thicker than thin blotting-paper. The dura mater bulged into the opening and did not pulsate. On pressure with the tip of the finger it felt like a well-inflated bicycle tire. As a measure of certainty I cut a narrow channel across the bone to the left occipital fossa. Here the bone was thicker and the intracranial pressure less. The opening into the dura was made with a knife by cutting down through it, and enlarged with blunt-pointed curved scissors. There was only the smallest quantity of cerebrospinal fluid lost. Before the opening in the dura had been extended one and one-half inches long the brain was forced through, forming a mass half as large as an English walnut. The pressure was so great that I could not palpate the brain within, so I cut the protruding mass away. In an instant more brain was forced out, and this I also cut away. Only one artery from the cut brain surface bled, and this I controlled by touching lightly with a sharp point of a Paquelin cautery. I could then examine the brain with my finger, but could find no hardness which suggested a tumor.

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[1] I had the assistance of Drs. Hilt, Ward, Bruce, Rea, Bledsoe, and Mr. Gulledge, a medical student.

During all this time the brain was irrigated with hot sterile salt solution. The portions of the brain removed and the cut surface presented an appearance which I thought at the time indicated an infiltrating lesion of the consistency of the healthy brain. Subsequent examination of the tissue removed showed it to be healthy, only stained here and there with blood—most probably operative hemorrhage. I decided that the growth could not be successfully removed unless I exsected most or all of the right cerebellar lobe, and this I did not think advisable. I purposely refrained from exploring the cerebellum with an aspirator needle or probe, although at one time I had the needle started into the brain tissue. This, however, was probably unfortunate, as it would most likely have revealed and evacuated the cyst. However, I chose to stop the operation, closed the dura, and hoped that the tumor would grow out of the opening of the bone and become more accessible to an operation in the future. The condition of the patient also warned against much further operative interference. With some difficulty the dura was closed over the brain with a continuous silk suture. The scalp wound was united throughout with silkworm-gut and a moist antiseptic dressing applied with moderate pressure.

The patient stood the operation well until toward the last. Hypodermics of strychnine had been given before and during the operation until she had taken fully the twentieth of a grain. As she was put into bed her respirations became very shallow, and in a moment ceased. Her pulse was fairly good and not much above 100 to the minute. I began artificial respiration, which was kept up for fully twenty-five minutes—the pulse remaining about the same—before she breathed; then two or three shallow respirations and a deep one, and an interval of a minute or more, and then shallow respirations again, gradually deepening until the breathing became established. Strychnine was given in one-sixtieth grain doses, internally, during the afternoon and night.

June 16th. Her general condition was good. She wanted breakfast, and a small quantity of food was allowed, which was eaten heartily. During sleep the night before her eyes had been closed, which gratified her mother very much. Her mind was clearer and more natural; the facial paresis was hardly noticeable. The pupils were only slightly dilated, and there was some reaction to light.

The recovery from the operation was uneventful. There was no rise of temperature beyond 99.5°, which occurred on several afternoons. On the eighth day after the operation I removed the dressing and most of the stitches. Union had been perfect. There was, however, a large hernia cerebelli, and I feared the wound would break from the pressure underneath the scalp, but this did not occur. Further examination revealed the fact that the weakness in her left side had greatly diminished; indeed, it was about as strong as her right. As she lay in bed her arms and legs were quite strong and their coarser movements fairly well co-ordinated. In the finer movements the inco-ordination was more marked. Her appetite had grown to be voracious. About this time there began an abnormally rapid growth of the body, which was noticed by everyone who knew her. She could not sit up in bed and would not attempt to raise herself up without something above to hold to with her hands. Two weeks later—about three weeks after the operation—when supported or tied in she could sit in a chair, but would tumble out in any direction the moment the support was removed. She could hold herself in, however, with her hands, by forcing herself hard against the back of the chair. While she could not stand or walk, she soon learned to crawl, which was done by placing her hands on the floor far apart, as a base of support, while her hips and legs would lie more inactive on the floor; then, in an unsteady, ungraduated manner, she would move her hands forward and drag her hips and lower extremity along. Later she was able to lift herself on her knees, and in this way could get along pretty well. She went up and down the steps and all about the house, and could also sit in a rocking-chair, and, with hands tightly grasping the sides, jump it about the floor.

She was cheerful and happy, and much of her original brightness had returned. The optic neuritis had subsided to some extent, but the eyesight had not improved; indeed, if it had changed at all, it was for the worse. She regained control of the sphincters. The knee-jerks were still totally absent in both legs. Her parents considered her very much improved in every respect except her eyesight.

During the second month after the operation the pressure symptoms became more marked. The paresis of the right facial nerve appeared again, the pupils were dilated as before, and were inactive, and the weakness of the left side was again established.

Her mental condition did not suffer in proportion to the other symptoms. The hernia cerebelli grew constantly, and became half as large as a medium-sized apple; it was also very tense. Headache, vertigo, or vomiting did not return, and she retained control of the sphincters.

A day had been fixed for the second operation, when the following accident occurred. Seated in a large-armed rocking-chair, by some means she pulled it over on her, and fell with her face against the floor, the top of the chair striking the protruding brain. This was August 17th. She screamed and complained for a few moments, and then became unconscious. I saw her in a short time after the fall. She was lying in bed, now and then moving her arms and legs; she could not speak, nor could she be aroused by loud calling; her corneæ were insensitive and the pupils widely dilated. Her breathing was shallow and slow, pulse full, strong, and not rapid, and the hernia cerebelli tense and hard. I decided that the chair in striking the unprotected mass of brain had ruptured a bloodvessel, and that there was a hemorrhage either into the tumor, or into the cerebellar fossa, or perhaps into the fourth ventricle.

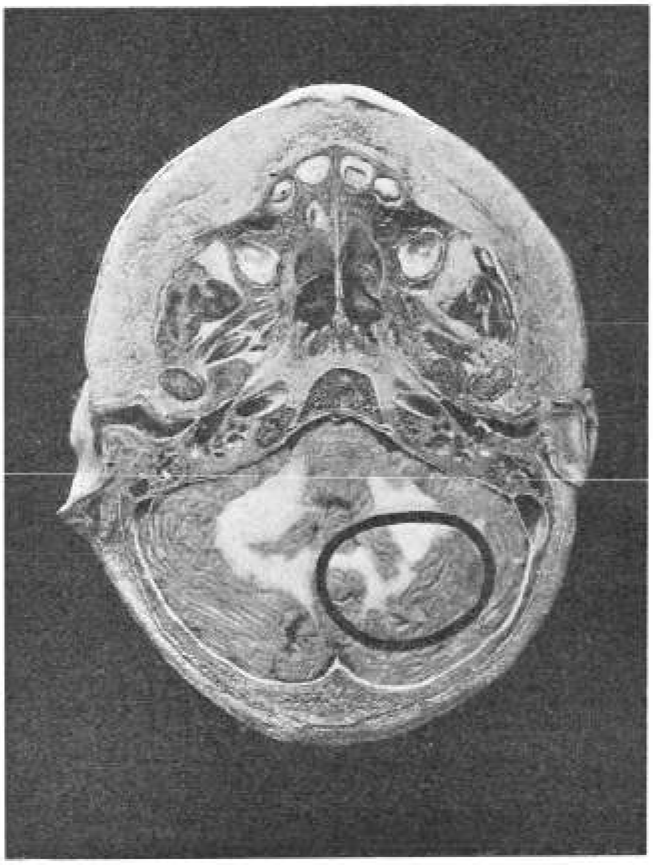
An operation was decided on as soon as it was possible to prepare for it.

I operated at 11.30 A.M. of the same day, with the assistance of Drs. Love and Rea and Mr. Denny. During the morning strychnine in one-sixtieth grain doses had been given hypodermically. A small quantity of ether was used during the operation.

The incision was made in the line of the old scar; the scalp was thick and healthy, but bled very little. It was easily separated from the mass of brain beneath, over which several bands of dura mater passed.

In examining the protruding mass of cerebellum I found it of a bluish tint, and apparently quite bloodless and easily broken. My finger readily penetrated the hernial tumor, and at once an ounce and a half to two ounces of fresh blood clot was ejected a foot or more away. There was fully as much bloody fluid thrown out at the same time, but it was lost in the towels and could not be examined. Some fresh blood followed the evacuation of the cyst, the hemorrhage continuing until I lightly packed the cyst cavity with sterile iodoform gauze. As I inserted the gauze I examined the cavity of the cyst; it was smoth in front, but posteriorly seemed to have been made up of irregular masses of compressed brain and membrane.

FIG. 1.



Left. Location of the cyst in Case I., viewed from above. Right.

The cyst had destroyed most of the right lobe, and much of the middle lobe of the cerebellum, and much of the left lobe by pressure. After the cyst cavity had been lightly packed with the gauze there was yet a remarkable emptiness in the cerebellar fossa. I am of the opinion that the direct damage done by the cyst, and the great pressure which it caused, had totally destroyed the functions of the cerebellum. During the operation there was only the very smallest quantity of cerebrospinal fluid lost. The condition of the patient improved from the moment that the cyst was evacuated. The scalp wound was closed with silkworm-gut sutures, placed farther apart than usual to allow drainage, and a moist antiseptic dressing applied. When put into bed the patient was in a very satisfactory condition. Within two hours she was conscious and able to talk. On the third day the dressing was changed to allow the removal of the gauze packing from the cyst cavity. The dressing was dry, and there had been no loss of cerebrospinal fluid, nor had there been any further hemorrhage. On August 19th she was in excellent condition. The paresis of the right facial nerve had entirely disappeared; the pupils were about the normal size and reacted to light; and the left side had regained most of its lost strength. There was, however, a marked weakness in her right arm and hand. These members for several days were almost paralyzed to motion.

A rapid operative recovery was made, and all the dressing and stitches were removed by the tenth day after the operation. Her appetite was good from the first, but was never voracious again.

I will not speak further of her condition until the end of the third week after the final operation. At this time the "shock" of the operation had passed off.

Lying in bed she appeared quite natural and healthy and well nourished; her eyes were not so prominent and the nystagmus was gone. She had fair control of her eyes, and could move them in any direction. There was no paresis of the facial nerve. The scalp wound was firm and healthy, and the opening in the occipital bone, instead of presenting a hernia, was concave, notwithstanding the fact that there was no dura mater over this part of the brain; indeed, all the indications of increased intracranial pressure were gone.

At this period her symptoms were the counterpart of the symptoms produced in monkeys when the cerebellum has been removed as a physiological experiment. Station and locomotion were altogther impossible. She could raise herself in bed by grasping your arms with her hands. When she did so, however, she exhibited the most tumultuous disorder of equilibrium—her head swaying and jumping, and an extraordinary unsteadiness pervading all the muscles of her body. When lying down, her legs and arms (with the exception of the weakness in her right arm and hand, which was fast disappearing) were strong and their co-ordination fairly good except for more delicate movements. Soon she learned to crawl again, which was done as before, with her hands placed far apart on the floor, so as to afford a broad base of support, then dragging her hips and legs along. Her hands were moved forward in a jerky, ungraduated manner. She could climb a ladder, going up several rounds, and while her movements were tottering, she appeared to ascend safely. Her knee-jerks had returned, a little livelier than natural and a little more marked in the right leg than in the left. The weakness of the muscles of the trunk, especially of the back, was even more marked than before the operation.

At the time at which this portion of the paper was written, four months after the final operation, the patient was in a most excellent condition. She was well and strong, and growing normally. She walked well, showing very few defects of co-ordination. All the symptoms that were produced by the intracranial growth had disappeared, except that she was blind. After prolonged exercise there was a slight tremor in the muscles, a little more marked about the head and trunk than elsewhere.

About a year after the final operation she was shown before a medical meeting in an adjoining State; at that time she was in splendid condition in every way. Walked many miles and enjoyed her visit as much as any blind child of her age could possibly have done. Her health continued good for about three years, and at that time symptoms of recurrence appeared, a solid mass growing into and through the opening made at the time of the operation. She was alive in November, 1902, but would not consent to another operation, though her parents very much desired that she should.

CASE II.—*Tumor of the cerebellum accurately located well forward in the right lobe; successfully removed. Apparent operative recovery. Death on the eleventh day from exhaustion, due to diarrhœa.*

History (Dr. Worth Stevenson). Mr. S. E. D., aged twenty-nine years; athlete, amateur base-ball player; occupation, bookkeeper; had always held positions of importance and with entire satisfaction to his employers. Family history negative. No history of lues; had two attacks of gonorrhœa, first several years ago; had not recovered from second attack when present illness began. At twelve years of age he was struck by a stone from a sling above and just behind the right ear. He was knocked down by the blow and the scalp was cut to the bone, but at the time the bone was considered not injured. He continued at school, and nothing was thought of the injury. A large white scar marks the injured spot. An intimate friend gave the information that several years before the present illness began the patient complained of a most peculiar effect which the smallest amount of any stimulant had on him. There is no history of even moderate drinking. He would on going to bed at night hang his head off the side of the bed for relief of a peculiar feeling in the head, but this feeling was not described as pain. He had also suffered from headaches, for many years before his present illness began, which were treated as migraine and considered as the ordinary migrainous type. In December, 1901, while in church at night, he saw the minister double, and was compelled to close one eye to see him naturally. On leaving the church he staggered so badly that he had to be assisted home. His history here is a little indefinite, but it is most probable that he had been staggering before, as an aunt of his told me that one day, while he was yet at business, she saw him staggering to the right and nearly falling off the sidewalk, and that she said to him that people would certainly think him drunk if he continued to stagger so. After he was assisted home he was compelled to take to his bed, which he kept for two weeks. During his stay in bed headache developed, sometimes diffuse, sometimes in occiput, sometimes frontal. At this time severe and obstinate vomiting made its appearance. He did not lose his appetite, and the bowels were natural. At the end of two weeks he had improved to such an extent that he resumed his work; but he was far from well, and remained at work for a few days only, when the headache, vomiting, and staggering returned with greater severity. He was compelled to take to his bed again, from which he was not able to rise without help, except on a few occasions. Later on he could not get out of bed without help. He lost appetite, but this and the frequent vomiting never led to extreme emaciation, though he lost much flesh and strength. It was noticed during the early part of 1902 that his vision was failing, and equally in both eyes. It was not noticed that there was deafness in either ear. With the onset of the severe symptoms, attacks, epileptic in nature, appeared. At times he had several of these attacks in one day, then one a day, then missing several days, to have several a day again. After these attacks there was some exhaustion and profuse general sweating. During these attacks the following phenomena were observed: Twitching in either leg; turning the eyes to the right; later, right eye did not turn on account of paralysis of the sixth nerve of the right eye. In some attacks the twitching began in the right side of the face, and the mouth would be turned violently to the right.

One striking symptom was the turning of the entire body, especially the head and shoulders, to the right (screwing-in turning). This turning to the right in bed was a most marked symptom, and persisted without intermission during his entire sickness. He was never comfortable lying in any other way, and would always insist on returning to this position when he was persuaded to lie in any other manner.

Inability to walk or stand was an early symptom, and the turning to the right (screwing-in), whether he was out of bed or in bed, was most striking. When held up he leaned to the right, and would have fallen to the right and backward if allowed to do so.

There was paralysis of the sixth nerve of the right eye, but the time this appeared was not definitely known; there was also the slightest paresis of the seventh nerve on the right side. The paresis did not appear to increase after the epileptic attacks, which began in the right side of the face. No electrical examination was made.

There was absolutely no change discoverable in motion or sensation in any portion of the body. When lying down co-ordination was good in all portions of the body. There was no aphasia of any kind, no mental changes, no tendency to joke or make puns, no unusual hilarity; indeed, his mind until toward the last was normal in every way. There was no loss of sphincteric control, and bowels and bladder were voided naturally.

When the patient came under my care (Dr. Stevenson) in June various things had been done for him by various physicians, but availed nothing. I had him take iodide of potash in gradually increasing doses, but his condition did not improve.

History continued (Dr. Hudson). When I first saw Mr. D. he was in bed, with his head and shoulders turned well to the right, the right side of his face touching the bed. When asked to change his position so that I could see his face he very reluctantly did so, saying he was very uncomfortable except when lying on his side and face, and that there was a constant desire to turn a little farther over. He never lay flat upon his face and abdomen. This is the rotation of screwing in the usual right-hand screw, the head of the patient being represented as the head of the screw.

The expression of Mr. D.'s face was a little peculiar, suggesting the faintest shadow of a cynical smile. There was paralysis of the sixth nerve of the right eye, and a faint paresis of the seventh nerve of the right side of the face, visible only when asked to move his face. The tongue was protruded in a straightforward manner and was otherwise normal. There was absolute deafness in the right ear, both to aërial and bone conduction. Cerebration was a little slow, although entirely normal otherwise. Members of his family and other acquaintances stated that his mind was perfectly natural and in no way changed from what it had been in years.

A careful examination failed to reveal any change in sensation or motion in any part of the body. He could touch the tip of his nose with either forefinger accurately; could touch his knees with the heel of either foot accurately; lying in bed he could lift his legs and feet in any direction, and could control them apparently without any defects. There was, however, just a suggestion of a little awkwardness in picking up a pin or buttoning his shirt; but this awkwardness was not greater than frequently seen in perfectly normal individuals.

For some months before I saw Mr. D. he had been losing his eyesight, and at the time of my examination could with difficulty count fingers; his vision was lost to about the same extent in both eyes. There was double optic neuritis of about the same degree in both eyes.

The most striking symptom in this case was the absolute inability to stand and the inability to sit in a chair unless the patient held himself in very tightly with his hands. When asked to crawl he could do so very readily, placing his hands and knees far apart so as to obtain a broad basis of support.

There was at the time of my examination no vertigo, and vomiting had almost entirely ceased. He complained more or less of headache, at times in the left frontal region, at times through the temples, but more especially in the right cerebellar region. Percussion did not reveal any point of circumscribed tenderness; but deep pressure revealed a marked circumscribed tenderness over the right lateral lobe of the cerebellum, most marked over the region of the tumor. The knee-jerks and ankle clonus were entirely absent.

During my second visit, while examining Mr. D., he notified me that he was about to have one of the epileptiform attacks. It began in the right side of his face, turning it strongly to the right; the attack lasted about thirty seconds. It did not become general, nor did it produce unconsciousness. It passed off quickly and the face was not more paretic than before. The attack was followed by profuse general sweating, but not by a tendency to sleep and not by increased weakness; indeed, the patient's condition, with the exception of profuse sweating, was practically the same as before the attack. There was no nystagmus.

The vomiting, double optic neuritis, headache localized under firm pressure over the right occipital lobe, staggering gait with turning to the right (screwing-in motion), the paralysis of the external rectus of the right eye and the paresis of the right seventh nerve, the deafness in the right ear, the absence of mental failure, and psychical changes indicated that there was a growth in the right cerebellar lobe, most probably situated well forward. An operation was advised, with all of its dangers and uncertainties, and after due deliberation was accepted by the patient's family and demanded by the patient.

The Operation.[1] Ether was the anæsthetic used, and, on account of ether maintaining blood pressure better than chloroform, should be used in preference to chloroform in all operations on the brain. The usual semicircular flap was made and the muscles separated from the bone with the blunt elevator. A small opening was made through the skull with a chisel and enlarged with rongeur forceps. The dura mater was found very tense, but not so tense as in Case I., and was opened the usual way by cutting through it near the margin of the opening in the bone. The intracranial pressure was much increased and the brain did not pulsate. The brain was explored with the finger, and the tumor found about three-quarters of an inch under the surface of the brain and in a slightly upward direction. The tumor was of much harder consistency than brain tissue, and was easily made out as a roundish body about the size of a pullet's egg. The finger was pushed behind the tumor and it was very readily enucleated, being fractured when it was pulled against the bony opening in the skull as it was being removed.

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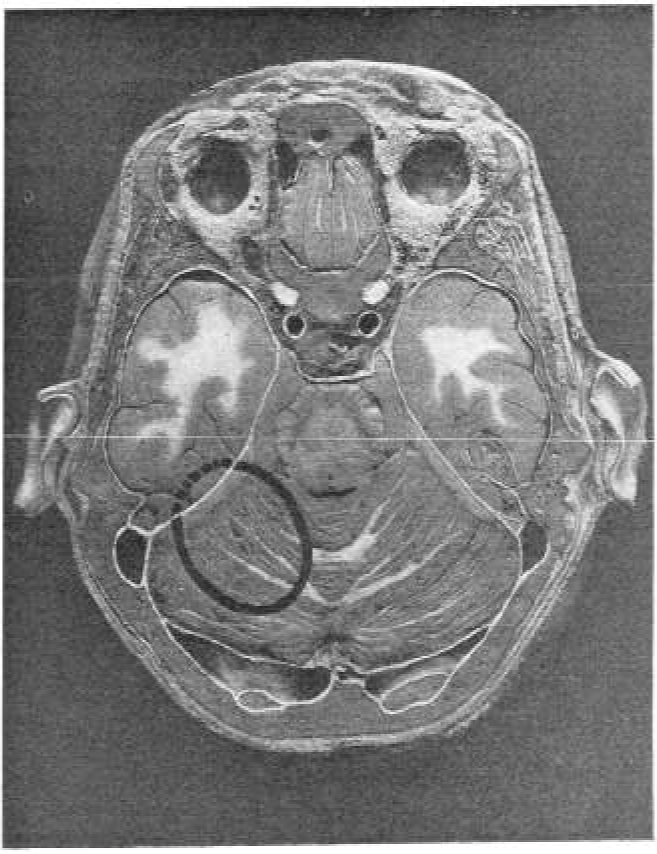
[1] I was assisted by Drs. Hooper, Disharoon, Dean, Stevenson, Floyd, Pate, and Jenkins.

FIG. 2.



Right. Location of the tumor in Case II., viewed from below. Left.

After the tumor was removed there was very little hemorrhage, and I explored very carefully and thoroughly with my finger the cavity made by the tumor and by the operative procedure necessary for its removal. Practically the entire right lobe of the cerebellum was destroyed, the tumor having occupied a position well forward in the right lobe of the cerebellum; the long axis of the tumor occupying a vertical position in the cerebellum, the upper pole touching the tentorium cerebelli, the lower pole pointing toward the floor of the cerebellar fossa. The tentorium had evidently been pushed upward to a considerable extent—enough to have pressed considerably upon the right occipital lobe—but we failed to discover any hemianopsia.

As in Case I., the possibility of respiratory failure had been considered; and, not to my surprise, just as the operation was being finished the patient ceased to breathe. Artificial respiration was resorted to, the pulse being very rapid and of very low pressure. It was necessary to continue artificial respiration for more than an hour; in the meantime the patient had come out from the anæsthetic sufficiently to understand what was said to him and to obey instructions. At this time a very curious phenomenon was observed. When artificial respiration was stopped the patient would cease to breathe immediately; but when he was commanded to breathe he would do so, using the voluntary muscles of respiration. At first this voluntary breathing would last about a minute, then breathing would entirely cease. When commanded to breathe again he would do so, the first few breaths being very deep and full; then they would gradually fade away again, each breathing period being longer than the previous one. This process was kept up for fully one hour before normal breathing returned, a person being kept by his side to remind him to breathe when breathing ceased. It appeared that this peculiar breathing process was carried on entirely through the voluntary breathing apparatus, and that the involuntary breathing centre did not assert itself for at least two hours after the breathing first ceased. In other words, the attendants kept up artificial respiration until the anæsthetic passed off sufficiently for the cerebral cortex to resume its functions; then the patient actually continued the artificial respiration on himself through the cerebral cortex and its connections with the intercostal muscles until the natural breathing centre in the medulla could become active again.

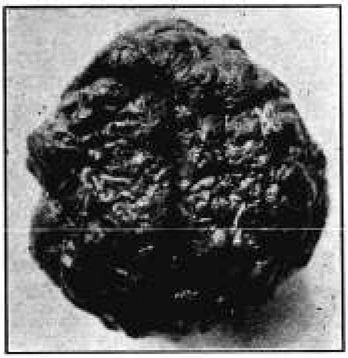
In three hours after the operation was performed the patient's condition was entirely satisfactory. His respiration varied from 20 to 30 per minute, and his pulse from 100 to 120 per minute. The paralysis of the sixth, seventh, and eighth nerves had not perceptibly changed, and there was absolutely no change in motion or sensation in any portion of the body by any of the tests used. The knee-jerks remained absent, and never returned again. The other reflexes were also the same as before the operation.

I did not see the patient again until the third day after the operation; at that time he appeared in a remarkably good condition, his temperature normal, and pulse 92 to the minute. He had been able to take egg albumen and beef peptonoid with relish. He spoke hopefully, said he felt very much better than he had felt for months, that his headache was entirely gone, and that his eyesight was very much improved. He had a very persistent inclination to turn over on his right side—screwing-in motion. This was more marked, if possible, than before the operation. Sensation and motion in legs and arms did not show any defects, and as he lay in bed co-ordination in these members appeared as it did before the operation, there being no discoverable weakness in the arm or leg of either side.

At this time the wound was dressed, and all the stitches and a small gauze drain, which extended to the depth of the wound from which the tumor came, were removed. There had been a slight discharge of bloody fluid, which had so long since ceased that the dressing was dry, and there was no further discharge of fluid when the drain was removed. There was no hernia of the brain, and the entire wound appeared in a perfectly satisfactory condition.

The patient had several times during the few weeks before the operation suffered from attacks of diarrhœa, coming on suddenly and disappearing under treatment within twenty-four hours. On the night of the third day following the operation he had such an attack of a very severe nature, and also vomited at the same time. Calomel and salol were given him by the attending physicians, and when I saw him, at noon on the fourth day, the attack had about disappeared and the patient was in much the same condition as on the previous day, except that he was a little weaker and a little less hopeful, and did not take his nourishment with quite the same relish.

FIG. 3.



Photograph of tumor removed from Case II. Natural size.

During the fifth day the diarrhœa returned, almost choleriform in nature, and his condition became perceptibly worse. He took nourishment badly and vomited occasionally, at the same time a mild intermission in breathing appearing. The wound was dressed again and the healing appeared perfect. On the eighth day the dysentery was not so bad, but he refused nourishment; his mind was very sluggish; he failed to answer questions; evidently did not understand what was said to him. His arms sweated profusely and were cyanotic, though in the other portions of the body sweating was not marked and the circulation was not changed. There was at this time most marked Cheyne-Stokes respiration, but there were no other signs of compression. Nevertheless, I feared there had been a hemorrhage into the tumor cavity, which had perhaps implicated the fourth ventricle; consequently, I explored the wound, but found no evidence of hemorrhage. There was quite a quantity of cerebrospinal fluid after the exploration, and the breathing very much improved for several hours. The patient's condition did not change until the afternoon of the ninth day, when all of the symptoms grew more unfavorable again, and he died from exhaustion on the eleventh day after the operation. It is very probable that the attacks of diarrhœa before and especially after the operation were due to involvement of the vagus by the tumor and more especially by the trauma of the operation.

No post-mortem examination was allowed.

The tumor was examined by Dr. Simon Flexner and found to be tuberculous.

The localization of tumors of the cerebellum, in the present state of our knowledge, appears to be a very difficult problem. In the hands of the most accurate observers mistakes in localization are about as frequent as successes, and up to the present time there seems to be no symptom or class of symptoms which are to be depended upon as positive in their localizing value.

Some cases of tumors in the lateral lobes have been reported which have produced no symptoms whatsoever, and were only found accidentally at the necropsy. Other cases have presented symptoms which were considered positive of the tumor being located in one lateral lobe, when in fact it was in the other; while other cases presenting all the classical signs of tumors of the cerebellum have proven that no tumor existed in the cerebellum at all, but instead there was found a dilatation of the ventricular system of the brain, more especially of the fourth ventricle, the result of previous meningitis and obliteration of the foramen of Magendie.

The cases reported here have been, perhaps, more than usually favorable for the accurate localization of the tumors. Let us see what symptoms in either case were deciding ones in locating the lobe in which the tumor existed. First, in Case I. there was positive localized tenderness on deep pressure over the tumor. In this case there was paralysis of the external rectus muscle of the eye on the side of the tumor. There was also paresis of the seventh nerve on the side of the tumor. There was also pain in the back of the neck on the same side of the tumor. These were the localizing symptoms in Case I. which led to the decision that the tumor was in the right lobe. There was also considerable loss of strength in the left side of the body, which was consistent with pressure in the right lobe of the cerebellum, pressing upon the pyramidal tract above its decussation. There was also a certain rotation in walking, which was considered of no localizing value.

A procedure at the operation which had never been done before nor since, nor has every been recommended by anyone, so far as I know—that of cutting a channel across to the opposite lobe—was of most positive value, and one which I would recommend in all cases where there is a question of localization. In this case the bone over the tumor was thinner than the bone over the lobe which did not contain the tumor; and the intracranial pressure was quite perceptibly different over the two lobes, being greater over the lobe containing the tumor.

In Case II. we have a similarity of localizing symptoms: First, the positive localized tenderness on deep pressure; second, paralysis of the external rectus of the eye on the same side as the tumor; third, paresis of the seventh nerve. But, different from Case I., there was absolutely no change from the normal in either side of the patient, either in sensation, motion, or strength. There was, however, one symptom which was considered of great localizing value, viz., absolute deafness, both to aërial and bone conduction, in the ear on the side of the tumor. There was also in Case II. a most decided rotation of the body on its long axis from left to right—the screwing-in turning of the ordinary right-hand screw—but as a localizing symptom this was considered of no value.

In Case II. a channel was not cut across to the opposite lobe, for the reason that the localization of the tumor in the right lobe was reasonably certain.

In Case I. the very slight involvement of the cranial nerve led to the belief that while the tumor was perhaps intramedullary, it was not so far forward as to lie upon the petrous portion of the temporal bone. In Case II., on account of deafness in the right ear and the possible involvement of the vagus nerve, the tumor was considered very probably well forward in the cerebellum; so that when the tumor was not seen after opening the dura mater it was considered proper to explore the cerebellum with the finger in the search of it.

There are some symptoms in the foregoing cases which, studied before and after the operation, are of sufficient importance to be considered somewhat in detail:

The Knee-jerks. When I first saw Case I. the knee-jerks were totally absent, and continued so to the time of the final operation. A very short while after the operation the knee-jerks had reappeared a little more marked than natural and to a greater degree in the right leg than in the left.

The destruction of the cerebellum in this case was, I believe, more extensive than in any other case reported in which an operation had been performed, and yet the knee-jerks promptly returned, and I cannot see what caused their return except the relief of pressure.

In Case II. the knee-jerks were absent for weeks before and had not returned, to any degree, on the third and fourth day after the operation, when the patient presented every appearance of a speedy operative recovery.

In the reports of tumors of the brain, and especially in tumors of the cerebellum, a good deal of stress, heretofore, appears to have been laid upon the existence or non-existence of the knee-jerks; but it is probable that the presence or absence of the knee-jerk is largely an accidental condition, and is dependent either upon intracranial pressure or upon degeneration of the posterior columns of the spinal cord. The fact that the knee-jerks returned in Case I. after the subtentorial pressure was removed would indicate that their absence was due not to degeneration in the posterior columns, but to pressure; and the fact that the knee-jerks did not return in Case II. after the operation would indicate that their absence was due to posterior column degeneration.

Pain. In estimating the symptoms of highest localizing value in the foregoing cases it is more than probable that greater stress was laid upon the circumscribed tenderness on deep pressure than to any other one symptom, unless it was a total deafness in the right ear in Case II.

Ferrier called attention to deep tenderness many years ago, and thought that it was of great localizing value.

A distinction should be made between superficial tenderness, which is frequently found in the headaches of intracranial tumors, and the tenderness on deep pressure, which was so admirably shown in the two cases here reported. The superficial tenderness, while it may be of considerable localizing value—as, for instance, in the muscles of the neck or below the external occipital protuberance in the lesions of the cerebellum—yet, generally speaking, it is not to be depended upon as an aid to localization, and is dependent upon general intracranial tension.

The deep tenderness and the definitely localized pain is of the highest value for localization, and is of meningeal origin, pointing either to a primary or secondary affection of the dura mater; and, as the foregoing cases prove, the dura mater may be rendered sensitive to deep pressure by a subcortical growth some distance away.

Rotation and Staggering. In Case I. there was staggering in a certain direction, namely, to the left; and just before the patient entirely lost ability to walk there was staggering to the right, but never a constant way of falling; but at no time could any localizing value be attached to these symptoms.

In Case II. there was a most marked rotation to the right—screwing-in turning—and staggering in the same direction. This existed for several months before the operation was performed, but to a more marked degree afterward, and practically when almost the entire right lobe of the cerebellum was destroyed. The rotation to the side of the tumor was in this case certainly due to a destructive lesion, which is in keeping with the accepted opinion on this subject.

It is believed that irritative lesions cause a rotation away from the side of the tumor, and destructive lesions toward the side of the tumor.

The main difficulty, it would appear, arises in deciding whether the lesion is an irritative or a destructive one; and until this problem has been solved much more dependence must be placed on more positive signs, such as one-sided paralysis of cranial nerves or circumscribed deep tenderness.

In studying the mechanical arrangement of the cerebellum and its bony and membranous envelopes it appears very probable that a tumor growing on the side of the cerebellum might push the brain against the solid bony wall on the opposite side, and produce paralysis on the side opposite to that in which the tumor grows, thus, as it were, producing symptoms by *contre coup.*

In Case I. there was loss of strength on the side of the patient opposite the tumor before the operation, due to pressure on the pyramidal tracts above their decussation; after the operation the weakness disappeared from the opposite side, but there was marked loss of strength in the arm on the side of the body corresponding to the location of the tumor. In Case II. there was no change in either side of the body before or after the operation.

From the standpoint of the surgeon, it is very desirable to know whether the tumor is in the median lobe or in the right or left lobe of the cerebellum; whether the tumor is extramedullary or intramedullary; whether it is situated in the anterior portion of the cerebellar fossa, or in the posterior portion of the cerebellar fossa, or in the petrous part of the posterior fossa; and to clear up these points the following symptoms need to be studied further:

The relation of pain, headache, or tenderness on deep pressure to the location of the tumor in the cerebellar and posterior fossæ, and to extramedullary and intramedullary tumors.

The relation of rotation and staggering to tumors located as specified in the above paragraph.

Hemiparesis and its relation to the side of the cerebellar growth.

Whether or not symptoms on the opposite side to the tumor are ever produced by *contre coup.* If symptoms are produced by *contre coup,* to differentiate these from the symptoms produced by the direct pressure of the tumor.

A careful study of all tumors by the X-ray.

Method of Operating on the Cerebellum. If the operation is to be performed on the right lobe, the skin incision should commence at a point on the superior curved line, half-way between the external occipital protuberance and the mastoid process on the left side of the skull. From this point it should be extended in a semicircular direction to the tip of the mastoid process on the right side, reaching a point about half an inch above the centre of the superior curved line on the side of the skull into which the exploration is to be made. When this flap is fully separated it will allow the exposure of the bone down to the margin of the foramen magnum, and when it is pulled toward the left the centre of the left fossa can be readily reached. By extending the incision to the tip of the mastoid on the left side the entire occipital region can be laid bare. The flap should be carefully separated from the bone, so as to leave the surface of the bone smooth, and all bleeding stopped by rubbing aseptic wax into the bleeding points. The opening in the bone should be made well below the lateral sinus with a small, semicircular, oval-pointed chisel and enlarged with rongeur forceps. The opening should be as large as the region will safely admit and, if deemed necessary, a narrow channel should be cut across to the centre of the opposite fossa. All bleeding from the cut surface of the bone should be promptly stopped by the use of aseptic wax. After the opening in the bone has been made and the edges carefully smoothed, the dura mater should be examined (if necessary, of both lobes) to see if there is a difference of intracranial pressure. The incision in the dura should be made, as in other operations on the brain, sufficiently far from the cut edge of the bone as to allow the edges of the dura to be sewed together. When the dura is opened, if the tumor is not immediately under the opening the intracranial pressure will generally be so great that a portion of brain will be forced out. If necessary, this should be cut away and all bleeding carefully stopped; then with the forefinger, either with gloves or without, a careful exploration should be made. If the tumor is of harder consistency than the brain it will be felt with the finger. Should the tumor be expected to lie well forward, the finger should be gently pushed for a considerable distance into the brain tissue. If an intramedullary tumor is found, the surgeon must decide as to its size, position forward, and whether or not it is distinct from the brain tissue or has infiltrated it. The condition of such patients is desperate, and when a tumor is found an effort should be made to remove it entire or partly, even to the extent of exsecting a portion of one lateral lobe.

If the tumor is suspected of being in the median lobe, the opening should be made to one side or the other of the occipital sinus, the dura opened here, and the median lobe explored. Should the tumor be found, the opening should be extended across to the other lateral lobe, the occipital sinus ligated, and the dura divided at a point below the lateral sinus. This will allow a slight examination of the upper surface of the cerebellum, depending on the amount of intracranial pressure.

If a cyst is found it should be freely opened, and if deep-lying no effort should be made to remove the cyst wall, but gently pack with sterile iodoform gauze. If the cyst is superficial an effort should be made to remove the wall.

There can be no doubt but that most cases are more safely operated on in two stages. At all events, when there are any indications whatsoever for this necessity, as soon as the bone opening is finished the scalp should be closed over sterile rubber tissue and the operation finished three or four days later.